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for

TITLE: DUAL CHANNEL REDUNDANT FIXED WIRELESS NETWORK LINK, AND METHOD THERFORE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of the Provisional Patent Application Ser.No. 60/253,205 filed 11/27/2000.

BACKGROUND – FIELD OF INVENTION

This invention relates to wireless network communicating link, specifically to redundant wireless network link formed by redundant wireless network devices.

BACKGROUND – DESCRIPTION OF PRIOR ART

Wireless communication system utilizes [[electro magnetic]] electro-magnetic wave as media to carry messages in between transmitting and receiving devices. In the art of fixed wireless networking, two wireless network equipments communicating to each other form a wireless network link. The wireless network link links the two networks that behind the wireless network equipments. [[Electro magnetic]] Electro-magnetic wave propagating in the free space may be affected by many factors. Thus causes the quality of the wireless network link unstable. Further more, [[the malfunction of wireless networking radio hardware will also cause the wireless network link poor quality, un-usable, even broken]] wireless networking radio hardware malfunction often causes wireless network communication link to be at poor quality, or even broken.

Fixed wireless networking is a duplex digital data networking system. Normally people deploy point to point and/or point to multi-point network with one Access Point (AP) communicating to the far end Subscribe Unit (SU) devices. [[When deploy the outdoor network]] To build an outdoor wireless network, people need to build a POP site on top of a high building or a tower, of which, a POP may comprise one or more APs and other network devices, such as router and/or ATM switch. The APs communicate to one or more far end SUs form point to point and/or point to multi-point wireless network links.

AP, SU type of wireless network has no redundancy feature. Partially link optimization can be achieved by turn on the choosing preferred AP function of the SU.

In the prior art of fixed outdoor wireless networking, the network device AP and SU are single channel devices. Network redundancy cannot be achieved. Turning on the SU feature of choosing preferred AP, increases the complexity of the network and causes the network unstable or fail.

Hardware failure will cause the communication between AP and SU cease; an unexpected interference at current wireless channel will also cause the communication between AP and SU to be unstable or cease. When link failure happens, it is impossible to keep the current communication between AP and SU until manual maintenance and hardware replacement. Obviously, this type of wireless network system cannot be used in mission critical applications.

Summary

A redundant wireless network link comprises two Dual Channel Redundant Fixed Wireless Link (RFWL) devices. One of them is running as a Service Equipment (SE) with two of its wireless network radio units turned on and both antennas attached to the radio units [[have the same]] having the same coverage area. The other (RFWL) device is running as Client Equipment (CE) with one of its wireless networking radio turned on and communicating with SE. The link quality monitoring features of CE is monitoring the link performance of the communicating radio unit. [[Once, link quality]] When link quality is below requirement, or link was down for any reason, CE will automatically switch the communication with SE to the alternate wireless network radio unit, thus to keep the communication between SE and CE continuously. A wireless network radio unit and the antenna attached to it is a wireless network channel. A RFWL device comprises two independence wireless channels, which do not interfere to each other because of cross polarization of the antennas and/or totally running at different wireless characters.

Objects and Advantages

Accordingly, one object and advantage of the invention is to provide high reliable redundant wireless network link, which comprises two Dual Channel Redundant Fixed Wireless Link (RFWL) devices.

Other objects and advantages are to provide a method of automatically monitoring the link quality at physical layer and the network performance at second layer (referencing ISO networking model), and switching to alternated channel to keep the

wireless link communicating in best condition and continuously when RF or hardware hazard happens.

Further objects and advantages are to provide wireless network connectivity to high reliability demand area; to provide simple network management and improve maintainability of the wireless network; to provide low cost in wireless networking operation.

Additional objects and advantages will become apparent from a consideration of the ensuing description and the accompanying drawings.

Brief Description of the Drawings

Fig. 1 shows a block diagram of the device with dual channel radio units and redundant wireless communication control function.

Fig. 2 shows the vertical and horizontal polarization of antenna.

Fig. 3 shows a typical point-to-point wireless link with present invention of Dual Channel Redundant Fixed Wireless Network Link.

Fig. 4 shows a typical point-to-multipoint wireless links with present invention of Dual Channel Redundant Fixed Wireless Network Link.

Fig. 5 is a flow chart of the initialization of the wireless link of the Client Equipment (CE) in the present invention.

Fig. 6 is the procedure of the wireless link of the Client Equipment (CE) working at redundant mode.

Fig. 7 is a flow chart of the link monitor procedure of the wireless link of the Client Equipment (CE) in the present invention.

Fig. 8 is a flow chart of switching to second radio channel procedure of the wireless link of the Client Equipment (CE) in the present invention.

DESCRIPTION-Preferred Embodiment

Fig. 1 illustrates a block diagram of the Redundant Fixed Wireless Network Link device 10 with two individual wireless networking radio channels 11,12, among which, radio111 and radio121 are connected to processor 101 via interface/bus 104, radio111 and radio121 can be the same or different type of radios. Antenna112 and antenna122 can be the same or different type of antennas. If radio 111 and radio121 are working at the same frequency band, then antenna112 is working at horizontal polarization; meanwhile, antenna122 is working at vertical polarization. If radio111 and radio121 are working at different frequency band, then the antenna112 and antenna122 do not have to work at different polarizations. Normally, different polarizations for Redundant Fixed Wireless Network Link device 10 are preferred. The wired LAN unit 102 is a connection port to connect the whole device 10 to the LAN 103. The control unit105 will control the activity of radio units, such as hardware turn on/off, and any other performance related operations. The firmware unit 106 contains the software that is necessary to configure the device to be Service Equipment (SE) type of radio function or Client Equipment (CE) type of radio function, and, the redundant function software is needed in accordance.

Fig. 2 illustrates the vertical and horizontal polarization of antennas. The channel 11 of Redundant Fixed Wireless Network Link device10 is working at horizontal polarization201, in particularly, the antenna112 is working at horizontal polarization201. The channel 12 of redundant wireless communication control function device 10 is working at vertical polarization 202, in particularly, the antenna122 is working at vertical polarization202.

Fig.3 illustrates a typical point-to-point wireless link with present invention of RFWL devices 10&10a. In which, the radio channel 11 (radio 111 and antenna 112) of RFWL device 10 is configured to work at horizontal polarization 201; the radio channel 11a (radio 111a and antenna 112a) of RFWL device 10a is configured to

work at horizontal polarization 201; Antenna 112 and antenna 112a are communicating to each other and form a horizontal wireless link 301. The radio channel12 (radio 121 and antenna 122) of RFWL device 10 is configured to work at vertical polarization 202; the radio channel12a (radio 121a and antenna 122a) of RFWL device 10a is configured to work at vertical polarization 202; Antenna 122 and antenna 122a are communicating to each other and form a vertical wireless link 302. The RFWL device 10 is connected to network311 via wired port 102. The RFWL device 10a is connected to network312 via wired port 102a. Thus, the network311 and 312 are linked together by the RFWL devices 10 and 10a with redundant wireless links 301 and 302. Between wireless links 301 and 302, one of them is configured to work as a primarily link; the other link is the redundant link. Once the primarily link performance is unqualified or failed, the system will switch to the redundant link, so as to keep the two networks connected continuously.

Fig.4 illustrates a typical point-to-multipoint wireless links with present invention. Among which, the radio channel 11 (radio 111 and antenna 112) of the RFWL device 10, the radio channel 11a (radio111a and antenna 112a) of the RFWL device 10a and the radio channel 11b (radio 111b and antenna 112b) of the RFWL device 10b are configured to work at horizontal polarization 201; Antenna 112 is communicating with antenna 112a and 112b to form the horizontal links 401a and 401b. The radio channel12 (radio 121 and antenna 122) of the RFWL device 10, the radio channel12a (radio 121a and antenna 122a) of the RFWL device 10a and the radio channel12b (radio 121b and antenna 122b) of the RFWL device 10b are configured to work at vertical polarization 202; Antenna 122 is communicating with antenna 122a and 122b to form the vertical links 402a and 402b. The RFWL device 10 is connected to network411 via wired port 102. The RFWL device 10a is connected to network412 via wired port 102a. The RFWL device10b is connected to network 413 via wired port 102b. Thus, the network 411 and 412 are linked together by the RFWL devices 10 and 10a with redundant wireless links 401a and 402a; The network411 and 413 are linked together by the RFWL devices 10 and 10b with redundant wireless links 401b and 402b. Between wireless links 401a and 402a, one of them will be configured to work as a primarily link; the other link will be the redundant link. Once the primarily link performance is unqualified or failed, the

system will switch to the other link, so as to keep the two networks connected continuously. Between wireless links 401b and 402b, one of them will be configured to work as a primarily link; the other link will be the redundant link. Once the primarily link performance is unqualified or failed, the system will switch to the other link to keep the two networks connected continuously. In this embodiment, the RFWL device 10 is configured to work as the Service Equipment (SE), the RFWL devices 10a and 10b are configured to work as the Client Equipment (CE). Even though, there are only 2 CEs show up in this embodiment, the number of CE of a real deployment can be more than two.

Preferred Embodiment – Operation

The operation of the present invention comprises link setup and smart redundancy. One RFWL device 10 is configured to be the Service Equipment (SE) to provide the wireless network coverage; and, one or multiple RFWL devices 10 are configured as Client Equipment (CE) to communicate to SE. The two wireless radio channels are configured with cross polarization antennas to minimize the cross interference between the two channels. CE is configured to be able to communicate with SE in both radio channels, one of the two channels is working as primary channel to communicate SE, the other is the back up alternate channel. Once started, the monitoring function of the CE is responsible to handle the redundancy functions.

Fig. 5 illustrates a flow chart of the initialization of the wireless link of the Client Equipment (CE) of present invention.

In this embodiment of initializing a RFWL device 10 is working at redundant mode. The processor will test the radio1 501, if it is functional, the processor will continue to test radio2 504, if radio1 is not functional, the processor will report error1 503,and then go to test radio2 504. If the radio2 test result 505 is not ok, the system will report error2 507 and go to check if CE is able and allowed to work at non-redundant mode 509 If the radio2 test result 505 is ok, the system needs to make sure if the both radios work fine 506 If only one of the radios is ok, the system will go to check if CE is able and allowed to work at non-redundant mode 509 If CE is able and allowed

to work at non-redundant mode 509, system will work at non-redundant mode 511; If CE is not able and allowed to work at non-redundant mode 509, the system will perform at link fail status 514. If both radios work fine 506, the system will select the primary radio channel 508. Then system will connect the primary radio channel to SE 510. If the communication via primary radio channel to SE works fine, system will work at redundant mode 513. If the communication via primary radio channel to SE does not work well, system will report error2 507, and then process to check if CE is able and allowed to work at non-redundant mode 509, and so on.

Fig. 6 illustrates a flow chart of start working at redundant mode procedure of the wireless link of the Client Equipment (CE) of present invention.

When redundant mode procedure starts, system will perform the link monitor procedure 601, and then check if the link is good 602. If the link is good, the system will continue to link monitor procedure, and so on, once the link is not good, the link monitor procedure will report error3 603, and then go to switch to the second radio channel procedure 604.

Fig. 7 illustrates a flow chart of link monitor procedure of the present invention.

In this embodiment, when link monitor procedure starts, system will check if the link is idle 701 If the link is not idle, system will perform the link quality check 704; if the link is idle, system will re-associate the radio 702, and then if the link is back up running 703 If the link is back up running, system will perform the link quality check 704; If the link is not back up running, system will perform the link fail operation 705, and then return 707 with the link status. The link quality check 704 is good, the system will perform the link ok 706 operation and then return 707 with the link status; If the link quality is not good, system will perform the link fail operation 705, and then return 707 with the link status.

Fig. 8 illustrates a flow chart of switch to second radio channel procedure of the present invention.

In this embodiment, When switch to second radio channel procedure starts, system will turn on the second radio channel 801. Then, connect the second radio to SE 802. Check if the second communicating with SE is well 803 If the second radio communicates with SE well, system will report working at non-redundant mode 805, and then ends the redundant working mode 807; If the second radio does not communicate with SE well, system will report link fail 806, and then end the redundant working mode 807.

Conclusion, Ramifications, and Scope

Accordingly, it can be seen that I have provided a wireless network link with smart redundancy capability, which is [[capable to monitor]] capable of monitoring the link performance, and can switch to alternate wireless networking channel for better performance and/or redundancy when link is in poor quality or broken; a method of smart redundancy, which can automatically monitor the link quality, link status, switch the channel, and report the current working status. The redundancy of the present invention is base on two complete wireless networking channel, including wireless networking radio and antenna of both SE and CE, and the free air electro magnetic wave propagation environment in between the two antenna. In another words, any failure caused by any element of the communicating channel will be detected by the monitoring features and can trigger the redundancy. Furthermore, the Dual Channel Redundant Fixed Wireless Link (RFWL) and method have additional advantages in that:

- The Redundant Fixed Wireless Network Link device 10 configured as SE can provide twice of the networking capacity at the same wireless network coverage area compare to the prior art. This multi-purpose design of redundancy and increasing capacity has a high efficient usage of the radio frequency of the wireless network.
- The link quality monitor is [[capable to detect]] capable of detecting the accumulated random interference by the statistic of the layer II network performance, and switch the radio channel.
- The redundant wireless network link of the present invention greatly cut down maintains time and cost of the wireless [[network operation. Provides]] network operation; provides a flexible timing schedule to service the problem link.
- It is now possible to deploy the wireless network to reliability sensitive applications.

Although the description above contains many specificities, these should not be construed as limiting the scope of the invention but as merely providing illustrations

of some of the presently preferred embodiments of this invention. Various other embodiments and ramifications are possible within its scope—For example,

- A redundant wireless network link can be formed by two of the wireless channel working at same frequency and same type of radio units with cross antenna polarizations.
- A redundancy can have two totally different wireless networking radios, as far as the two channels are not interference to each other.
- It is possible to deploy the dual Redundant Fixed Wireless Network Link in some environment to provide the mobile wireless networking connections.

Thus the scope of the invention should be determined by the appended claims and their legal equivalents, rather than by the examples given.

Claims: What is claimed is:

1-5 (canceled)

6(new), One dual-channel redundant wireless link (RFWL) device comprising:

two separate wireless networking radios that can communicate with remote correspondent wireless networking radios forming a wireless networking sub-link via antenna means;

processor means running system features for SE;

one wired LAN interface for connecting to computer LAN;

one interface/bus means

wherein processor means running redundant communication features means for communicating with remote said RFWL device; and

whereby said two separate wireless networking radios are attaching to processor means via said interface/bus means; and

wherein said two separate wireless networking radios can communicate to the correspondent wireless networking radios remote said RFWL device.

7(new), One dual-channel redundant wireless link Service Equipment (SE) comprising:

one said RFWL device of claim 6; and

wherein said processor means of said RFWL device running redundant communication service features means for communicating with the CE of claim 8.

8(new), One dual-channel redundant wireless link Client Equipment (CE) comprising:

one said RFWL device of claim 6; and

wherein said processor means of said RFWL device running redundant communication client features means for communicating with said SE of claim 7.

9(new), The dual-channel redundant wireless link Service Equipment (SE) of claim 7 wherein said redundant communication service features means has feature means of having one of said wireless networking radio channels communicating

with the said correspondent wireless networking radio channel of the said CE of claim 8, and the other of the said wireless networking radio channels of claim 7 working at standby mode for communicating with the correspondent wireless networking radio channel of the said CE of claim 8.

10(new), The dual-channel redundant wireless link Service Equipment (SE) of claim 7 wherein said redundant communication service features means has feature means of communicating to said a plurality CE of claim 8 with one of said wireless networking radio channels communicating with the said correspondent wireless networking radio channels of a plurality of said CE of claim 8; and the other one of the said wireless networking radio channels communicating with the said correspondent wireless networking radio channels of other a plurality of said CE of claim 8, and said wireless networking radio channels that is not communicating with the same said CE having standby communicating feature means for take over the communication with the same said CE when the first communication link stops.

11(new), The dual-channel redundant wireless link Client Equipment (CE) of claim 8 wherein said redundant communication service features means has feature means of having one of said wireless networking radio channels communicating with the said correspondent wireless networking radio channel of the said SE of claim 7; and the other of the said wireless networking radio channels of said CE working at standby mode for communicating with the correspondent wireless networking radio channel of the said SE.

12(new), The dual-channel redundant wireless link Client Equipment (CE) of claim 8 wherein said redundant communication service features means has feature means of having one of the better said wireless networking radio channels communicating with the said correspondent wireless networking radio channel of the said SE of claim 7, and the other of the said wireless networking radio channels of said CE working at standby mode for communicating with the correspondent wireless networking radio channel of the said SE.

13(new), The dual-channel redundant wireless link Client Equipment (CE) of claim 8 wherein said redundant communication client features means has the feature means comprising:

selecting primary radio channel to communicate with up link SE; and

working at redundant mode; and

working at non-redundant mode; and

recovering from non-redundant mode to redundant mode; and

monitoring link quality.

14.(new) One point-to-point dual-channel redundant wireless link connecting two computer networks comprising:

one said Service Equipment (SE) of claim 7;

one said Client Equipment (CE) of claim 8;

one main computer network;

one client computer network

Wherein the two separate wireless networking radios of said Service Equipment (SE) communicating with remote correspondent wireless networking radios of said Client Equipment (CE) forming two wireless networking sub-links via antenna means; and

whereby said SE is communicating with said CE with one of the two wireless separate wireless networking sub-links; and

whereby said SE is connecting with one said main computer network with it wired network interface; and

whereby said CE is connecting with the other said client computer network with it wired network interface; and

wherein said two wireless separate wireless communication sub-links between said SE and CE forming a redundant wireless communication link between the SE and CE; and

Wherein one of the said two wireless communication sub-link continue communicating between the communicating SE and CE, when the other sub-link is off communication; and

whereby said main computer network communicating with said client computer network via the dual channel redundant wireless link formed by the correspondent communicating SE and CE.

15.(new) One point-to-multi-point dual-channel redundant wireless network comprising:

one Service Equipment (SE);

a plurality of Client Equipments (CE);

one main computer networks;

a plurality of client computer networks;

Wherein the two separate wireless networking radios of said Service Equipment (SE) communicating with remote correspondent wireless networking radios of said Client Equipment (CE) forming two wireless networking sub-links via antenna means; and

whereby said CE is communicating with said SE with one of two wireless separate wireless communication sub-link; and

Wherein the two separate wireless networking radios of said Service Equipment (SE) communicating with remote correspondent wireless networking radios of said a plurality of Client Equipments (CEs) forming two point-to-multi-point wireless networking sub-links via antenna means; and

whereby said SE is communicating with one group of said a plurality of CEs with one of said two point-to-multi-point wireless networking sub-links and the other group of said a plurality of CEs with the other one of the said two point-to-multi-point wireless networking sub-links; and

whereby said SE is connecting with one said main computer network with it wired network interface, and

whereby said CE is connecting with the other said client computer network with it wired network interface, and

wherein said two wireless separate wireless communication links between said SE and CE forming a redundant wireless communication link between the SE and CE, and

Wherein one of the said two wireless communication sub-link continue communicating between the communicating SE and CE, when the other sub-link is off communication, and

whereby said main computer network communicating with said a plurality of client computer networks via the dual channel redundant wireless link formed by the correspondent communicating SE and CEs.

16(new), Method of point-to-point dual-channel redundant wireless link comprising:

connecting said wired interface of said SE of claim 14 to said main network of claim 14; and

setting said SE ready to communicating with remote said CE of claim 14; and running dual-channel communication features at said SE; and

connecting said CE of claim 14 to the said client network of claim 6; and running dual-channel communication features at said CE; and

communicating said CE to said SE redundantly.

17(new), Method of point-to-multi-point dual-channel redundant wireless link comprising:

connecting said wired interface of said SE of claim 15 to said main network of claim 15; and

setting said SE to communicating with a plurality of remote CE of claim 15; and

running dual-channel communication features at said SE; and

connecting a plurality of CE of claim 15 to their correspondent said client network of claim 15; and

running dual-channel communication features at said a plurality of CEs; and

communicating said a plurality of CE to said SE redundantly.

Dual Channel Redundant Fixed Wireless Link, and Method Therefore

Abstract:

A dual channel redundant wireless network link formed by the Redundant Fixed Wireless Network Link device 10 of the present invention provides a very high reliable network element for mission critical wireless network application. Redundant Fixed Wireless Link device (10) with two wireless networking radio channel (11,12) turned on simultaneously, and running networking service feature is working as Service Equipment (SE). Both wireless networking radio channel (11,12) of the SE have the same directional wireless network coverage area. The two wireless networking radio channels (11,12) are separated by cross polarization of antenna at same radio frequency, or different [[radio frequency character]] radio frequency characteristics. One Redundant Fixed Wireless Link device (10) with one of its two wireless networking radio channel (11,12) turned on and communicating with said SE, and loaded with networking client feature is acting as Client Equipment (CE). The link quality monitor feature of the CE is monitoring the communication link between the SE and CE. When the current link quality is low or the link is down, the CE automatically switches on the alternate wireless networking radio channel (11,12) to maintain the network communication between the SE and CE. One SE may communicate with plurality of CE in the same wireless network coverage area.